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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/605,782	10/27/2003	Tzu-Yu Wang	12009-US-PA	2781

31561 7590 12/23/2005

JIANQ CHYUN INTELLECTUAL PROPERTY OFFICE
7 FLOOR-1, NO. 100
ROOSEVELT ROAD, SECTION 2
TAIPEI, 100
TAIWAN

EXAMINER	
GURLEY, LYNNE ANN	

ART UNIT	PAPER NUMBER
2812	

DATE MAILED: 12/23/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

EV

Office Action Summary	Application No.	Applicant(s)
	10/605,782	WANG, TZU-YU
	Examiner	Art Unit
	Lynne A. Gurley	2812

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-7 and 9-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-7 and 9-16* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Lynne A. Gurley

LYNNE A. GURLEY
PRIMARY PATENT EXAMINER
TC 2800, AU 2812

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to the after-final amendment, filed 12/8/05.

Currently, claims 1, 3-7 and 9-16 are pending.

Response to Amendment

1. Applicant's request for reconsideration of the finality of the rejection of the last Office action is persuasive and, therefore, the **finality of that action is withdrawn**. A new non-final office action is as follows:

Specification

1. The disclosure is objected to because of the following informalities: In paragraph [0004], lines 1-4, "As result of" should be changed to "As a result of".

Appropriate correction is required.

2. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. Claims 1, 3-7 and 9-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maiti et al. (US 5,885,870, dated 3/23/99) in view of Kusumi et al. (US 6,545,312, dated 4/8/03, filed 7/3/01) and further in view of Ohmi et al. (US 6,551,948, dated 4/22/03, filed 5/31/01).

Maiti shows the method substantially as claimed, in figures 1-5 and corresponding text, as, a method for forming a nitrided tunnel oxide layer 22 (fig. 4), comprising: forming a silicon oxide layer as a tunnel oxide layer 14/16/18/20 (figs. 1-3) on a semiconductor substrate 12; performing a nitridation process to introduce nitrogen atoms into the silicon oxide layer; and performing a thermal drive-in process to diffuse the introduced nitrogen atoms across the silicon oxide layer (column 2, lines 45-51). The Examiner takes the position that it is inherent that the annealing process will produce the nitrogen atoms to thermally diffuse across the silicon oxide layer. Also, see lines 6-9 for annealing relieving stress and densifying the silicon dioxide layer, which also inherently contributes to diffusivity. Also, see Ramsbey et al., US 6,252,276, column 6, lines 22-25, for subsequent annealing of nitrogen, after deposition, and its resulting diffusion through a tunnel oxide.). The nitridation process utilizes N2 (column 2, lines 32-51). The thermal drive-in process comprises a furnace annealing process or a rapid thermal annealing process (column 3, lines 5-42). The thermal drive-in process is conducted under 850 to 1100

degrees C for 30 seconds to 1 hour (column 2, lines 44-51). Also, see column 3, lines 48-67; and, column 4, lines 1-6 and lines 18-20, especially where Maiti discloses that the process is not limited to any specific process chamber or diffusion system, could be insitu or be performed in multiple chambers and apparatuses.

Maiti lacks anticipation only in not specifically teaching that a plasma nitridation process is performed to introduce nitrogen atoms into the silicon oxide layer; that forming the silicon oxide layer comprises performing an in-situ steam generation (ISSG) process; the plasma nitridation process utilizes N2 plasma; and, that the plasma nitridation process is conducted under a temperature lower than 400 degrees C.

Kusumi teaches a conventional process for forming a tunnel oxide by performing an in-situ steam generation (ISSG) process (fig. 15; column 26, lines 1-67; column 27, lines 1-35).

Ohmi teaches a nitridation process for tunnel oxide, also in a flash memory device, wherein a low temperature (about 400 degrees C) plasma nitridation process is used to improve the characteristics of the tunnel oxide for benefits mentioned in Ohmi. See column 1, lines 14-17, lines 57-62; column 2, lines 30-41; column 3, lines 15-26; column 5, lines 15-20; column 6, lines 44-53; column 21, lines 50-59. Additionally, in embodiments 1-2, columns 8-14, Ohmi teaches that the process is applicable to both oxides and nitrides grown on a silicon substrate.

It would have also been obvious to one of ordinary skill in the art to have formed the silicon oxide layer comprising performing an in-situ steam generation (ISSG) process, in the method of Maiti, with the motivation that since Maiti forms the silicon oxide layer first, before nitriding, and Maiti discloses forming the silicon oxide by thermal process, a conventional ISSG steam process, as taught in Kusumi, would have been efficient in forming the silicon oxide layer,

prior to the plasma nitridation for the reasons taught in Kusumi, such as improved reliability and nearly uniform thickness of the oxide and equal or superior quality to other oxide formation processes (Fig. 15; column 26, lines 1-67; column 27, lines 1-35 for the ISSG process as well as additional reasons and improvements by using the ISSG process).

It would have been obvious to one of ordinary skill in the art to have had a plasma nitridation process performed to implant nitrogen atoms into the silicon oxide layer, in the method of Maiti as modified by Kusumi; to have had the plasma nitridation process utilize N2 plasma; and, to have had the plasma nitridation process be conducted under a temperature lower than 400 degrees C, in the method of Maiti as modified by Kusumi, with the motivation that Ohmi teaches a more efficient and highly effective low temperature process to use a plasma process to nitride the tunnel oxide grown on the silicon substrate, as an alternative to conventional thermal growth or CVD, while improving the device characteristics.

6. Claims 1, 3-7 and 9-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mahajani et al. (US 2005/0062098, dated 2/24/05, filed 9/23/03) in view of Ohmi et al. (US 6,551,948, dated 4/22/03, filed 5/31/01).

Mahajani shows the method substantially as claimed, in figures 1-5 and corresponding text, as, a method for forming a nitrided tunnel oxide layer 22 (fig. 4), comprising: performing an in-situ steam generation (ISSG) process to form a silicon oxide layer as a tunnel oxide layer 20 (fig. 3; [0013], [0034], [0042]-[0045]) on a semiconductor substrate 10; performing a nitridation process to introduce nitrogen atoms into the silicon oxide layer (nitride layer 30 [0035]); and performing a thermal drive-in process to diffuse the introduced nitrogen atoms

across the silicon oxide layer ([0045] annealing can be performed after the oxidation process, which also may be performed in nitrogen and oxygen). The Examiner takes the position that it is inherent that the annealing process will drive-in the nitrogen atoms and produce the nitrogen atoms to thermally diffuse across the silicon oxide layer. Also, see Ramsbey et al., US 6,252,276, column 6, lines 22-25, for subsequent annealing of nitrogen, after deposition, and its resulting diffusion through a tunnel oxide.). The nitridation process utilizes NO or NH3 or N2O ([0036], [0045]). The thermal drive-in process comprises a conventional annealing process.

Mahajani lacks anticipation only in not specifically teaching that a plasma nitridation process is performed to introduce nitrogen atoms into the silicon oxide layer; the plasma nitridation process utilizes N2 plasma; and, that the plasma nitridation process is conducted under a temperature lower than 400 degrees C and specifics of the nitridation process and thermal drive-in process.

Ohmi teaches a nitridation process for tunnel oxide, also in a flash memory device, wherein a low temperature (about 400 degrees C) plasma nitridation process is used to improve the characteristics of the tunnel oxide for benefits mentioned in Ohmi. See column 1, lines 14-17, lines 57-62; column 2, lines 30-41; column 3, lines 15-26; column 5, lines 15-20; column 6, lines 44-53; column 21, lines 50-59. Additionally, in embodiments 1-2, columns 8-14, Ohmi teaches that the process is applicable to both oxides and nitrides grown on a silicon substrate.

It would have been obvious to one of ordinary skill in the art to have had a plasma nitridation process performed to implant nitrogen atoms into the silicon oxide layer, in the method of Mahajani; to have had the plasma nitridation process utilize N2 plasma; and, to have had the plasma nitridation process be conducted under a temperature lower than 400 degrees C,

in the method of Mahajani, with the motivation that Ohmi teaches a more efficient and highly effective low temperature process to use a plasma process to nitride the tunnel oxide grown on the silicon substrate, as an alternative to conventional thermal growth or CVD, while improving the device characteristics. Processing parameters such as temperature and duration of processing and specific type of anneal such as RTP or furnace, use of N2 plasma are considered parameters of optimization, especially without expressed criticality.

Response to Arguments

7. Applicant's arguments with respect to claims 1-16 have been considered but are moot in view of the new ground(s) of rejection.

8. Applicant's arguments, see the amendment, filed 12/8/05, with respect to claims 1-16 have been fully considered and are persuasive. The finality of the previous office action has been withdrawn. The new non-final office action above addresses the incorporation of the ISSG limitation into the independent claims and provides new prior art pertaining to the same.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: See US 2005/0224860 and US 6,803,272 for ISSG formed tunnel oxide.

10. Additionally, the prior art made of record in the previous office action and not relied upon is considered pertinent to applicant's disclosure. See Han et al. (US 6,461,984 for a N2O plasma oxide as a tunnel oxide. Also, see Pham (US 2003/0073288, US 6,605,511) and Guo et al. (US 5,918,125) for disclosure of nitrided tunnel oxides.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynne A. Gurley whose telephone number is 571-272-1670. The examiner can normally be reached on M-F 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on 571-272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Lynne A. Gurley
Primary Patent Examiner
TC 2800, Art Unit 2812

LAG
December 20, 2005